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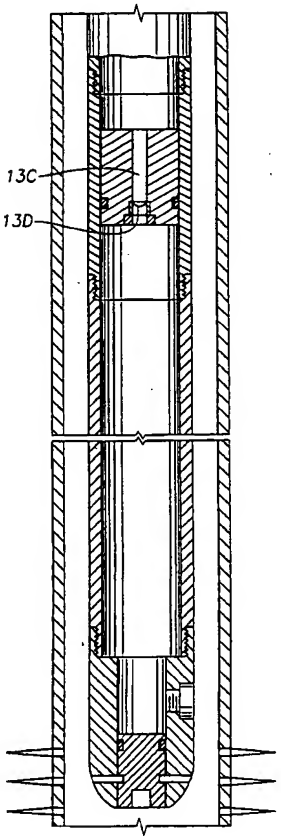
## (54) Treatment fluid injection apparatus and method

(57) A fluid injection apparatus (10) and method provides a controlled volume displacement for use of the apparatus in a subterranean well. Pressure is applied within a conduit carrying the apparatus into the well for activating a piston (13) and contracting a chamber (20) containing a treatment fluid for ejection of the treatment fluid into the well. A plurality of chambers may be isolated by the piston means relative to the conduit passageway for selective, incremental, ejection of the fluid and treatment of one or more zones or sections within the well.

Fig. 3




EP 1 223 303 A1

## Description

### BACKGROUND OF THE INVENTION

(1) FIELD OF THE INVENTION:

**[0001]** The invention pertains to a fluid injection apparatus and method with controlled volume displacement for use in the treatment of one or more zones or sections within a subterranean well.

(2) DESCRIPTION OF THE PRIOR ART:

**[0002]** During the drilling, completion or workover of a subterranean oil or gas well, it has been necessary or desirable to place a specific volume of a "treatment fluid" such as an acid, a polymer, a "sporting" fluid, corrosion or scale inhibitor, or other similar and known chemical, such as cement, plastic, epoxy, gel, or the like, in a precise amount and at a precise location within the wellbore. This has been accomplished in the past by use of a "bailer" which is introduced into the well on a wireline, or the like. The bailer contains a specific volume and is activatable due to density differential of the treatment fluid relative to the natural fluids in the wellbore at the time and location of treatment. However, this long established procedure is not entirely satisfactory in highly deviated wells or when tubing has become "corkscrewed." Additionally, when bailer systems have been utilized, and it is required that a specific, precise amount of treatment fluid must be injected into the well, such specific, desired amount of the placement or treatment fluid may not be totally ejected from the interior of the bailer, thus reducing the anticipated and required amount of treatment fluid for the particular zone application. Even when this problem is overcome by the use of a "positive displacement" bailer system in which a gravitational weight bar is used to push a piston with a wiper seal through the bailer string, thus wiping the inside wall of the bailer clear, such additional step is often times extremely time consuming resulting in utilization of additional expensive workover or other rig time.

**[0003]** The present invention addresses the problems associated with such prior art apparatuses and methods.

**[0004]** Fig. 1 is an elevational cross-sectional view of the apparatus of the present invention introduced to a predeterminable location within a subterranean well and prior to activation.

**[0005]** Fig. 2 is a view similar to that of Fig. 1 taken subsequent to activation of the apparatus.

**[0006]** Fig. 3 is a view of an alternative preferred apparatus in the position as shown in Fig. 1.

**[0007]** Fig. 4 is a view of the apparatus of Fig. 3 subsequent to activation.

**[0008]** Fig. 5 is a longitudinal cross sectional view of another alternative embodiment of the present invention incorporating plural chambers and piston means and shown in the position prior to activation.

**[0009]** Fig. 6 is a view of the apparatus of Fig. 5 subsequent to activation of one of the piston means in one of the chamber elements.

**[0010]** Fig. 7 is a view of the device shown in Figs. 5 and 6 subsequent to activation of a plurality of piston elements within their respective chamber means for discharge of a plurality of treatment fluids, either concurrently or in tandem.

**[0011]** Fig. 8 is an illustration of yet another embodiment of the present invention wherein the chamber means is provided by the interior walls of the conduit introduced into the subterranean well.

### SUMMARY OF THE INVENTION

**[0012]** The present invention provides a fluid injection apparatus with controlled volume displacement for use in ejecting a treatment fluid in a subterranean well. The device is carriable into the well on a conduit, such as continuous coil tubing, a workover string, or by wireline. Preferably, the conduit will be a workover string or continuous coiled tubing or other conduit having a fluid passageway interiorally thereof. The apparatus of the present invention may comprise a cylindrical housing having an interior fluid chamber for receipt of the treatment fluid. Means, such as threads, are provided at one end of the housing for securing the apparatus to the conduit. Piston means are carried within the chamber for isolating fluid within the chamber from the passageway and are movable from a first position whereby the chamber is in expanded condition retaining fluid therein to a second position whereby the chamber is in a contracted condition and the treatment fluid is ejected from the chamber into the well.

**[0013]** It is contemplated herein that the apparatus of the present invention may be carried into a well on a conduit other than one having an interior fluid receiving passageway, such as by wire or electric line. However, when such conduit is utilized with the present invention, means must be incorporated therein in conventional fashion for providing application of pressure to one side of the piston means for moving same to contract the chamber and eject the treatment fluid.

**[0014]** The apparatus may be provided in a form whereby it is not an independent tool or component specifically carried by the conduit and is provided as an integral component part of the conduit. Moreover, the apparatus may be provided in a form in which tandem or sequential ejection of separate treatment fluids is accomplished by utilizing two or more "stacked" chambers and pistons either provided in parallel, horizontal or vertical alignment.

**[0015]** The present invention provides positive controlled volume displacement of a treatment fluid and can accommodate pumping volumes as low as 3 gallons to 2 gallons of fluid per minute. This permits specialized, controlled pumping operations of expensive treating

chemicals, such as polymers, chelants, monomers, cross-linking agents, reaction catalysts, chain stoppers, acids, buffering agents and the like. This controlled displacement insures that treating fluids are not over displaced and are located at the proper treatment interval within the well.

**[0016]** In one embodiment, the present invention provides a diaphragm or similar component, housed within the floating piston element, which is rupturable or otherwise openable to a passageway within the conduit for circulation in the treatment chamber and the fluids in the well, in one of many known fashions.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0017]** Now, with first reference to Fig. 1, there is shown the fluid injection apparatus 10 of the present invention secured at threads 11 to a conduit CT having a series of radially disposed pressure relief ports PRD immediate the lowermost end thereof that are normally covered by an interior sliding sleeve mechanism (not shown). As stated above, the conduit CT may be continuous coiled tubing, conventional workover or drillstring, or the like. The conduit CT has a fluid passageway FP therein for introduction of a pressureable fluid for activating the apparatus 10 as described below.

**[0018]** The apparatus 10 comprises a cylindrical housing 12 secured at its uppermost end to the conduit CT by the threads 11. The cylindrical housing 12 has an interior smooth wall 12A' for receipt of a floating piston 13 having a upper face 13A in communication with the fluid passageway FP. A lower face 13B defines the uppermost, or one, end of a fluid chamber 20. An O-ring seal 14 is contained within a circumferentially defined grooveway 14A around the outermost circumference of the floating piston 13 for sealing movements along the smooth wall 12A of the interior of the cylindrical housing 12.

**[0019]** The cylindrical housing 12 of the apparatus 10 also provides a piston seat sub 12A having an upwardly facing-inwardly extending shoulder abutment 12B for terminating the lower travel of the floating piston 13, as described, below. A port 12C is defined within the piston seat sub 12A to permit filling of the fluid chamber 20 with the desired treatment fluid prior to introduction of the fluid apparatus 10 to the wellbore WB. The port 12C is sealed by introduction of plug 12D in securement within the plug port 12C subsequent to the filling of the fluid chamber 20 at the top of the well. The port 12C and plug 12D may, of course, be deleted and the apparatus 10 filed at the top of the well before introduction into the well.

**[0020]** A stinger element 12E is secured by threads $12E^1$ to the lowermost end of the piston seat sub 12A. The stinger 12E contains a blowout plug 15 which is secured in place to block the lowermost end of the fluid injection apparatus 10 by means of a series of radially extending shear pins 13, 14. Fluid communication between the exterior of blowout plug 15 and the interior of the stinger 12E is prevented by means of provision of an O-ring seal element 16 housed within a groove 16A.

**[0021]** As shown in Fig. 1, the apparatus 10 has been run into the wellbore WB for desired treatment of fractures F through perforations P in casing C.

**[0022]** Now with reference to Fig. 3, the floating piston 13 may contain an opening 13C therethrough as well as a rupturable diaphragm member 13D at the inwardly extending face 13B of the floating piston 13. The opening 13C is provided within the floating piston 13 to permit fluid pressure in the fluid within the fluid passageway FP of the conduit CT to be applied to the diaphragm 13D to rupture same subsequent to activation of the apparatus 10 as described below, to permit subsequent introduction into the wellbore WB of the fluid within the fluid passageway FP for subsequent treatment of the well through the perforations P, or any other desired, and known, purpose.

**[0023]** Now referring to the embodiment shown in Figs. 5, 6 and 7, a plurality of tandem, parallel floating pistons 13 may be provided in a fluid injection apparatus 10 which contains companion fluid chambers 20 and $20^1$ separated by a chamber isolator 17. The shear pins 113 and $113^1$ may provided with separate shear load or strength characteristics such that one of the blow out plugs 15 is ejected out the lowermost end of the apparatus 10 prior to breaking or shearing of the other pin $13^1$ to subsequently eject the blowout plug $15^1$ from the lowermost end of the fluid chamber $20^1$. They may also, of course, have the same shear load resulting in simultaneous breaking. Likewise, the rupture rating of the disk 13D and $13D^1$ are varied such that one of the passageways 13C is open before the other passageway $13C^1$ is opened for sequential introduction of the fluid within the fluid passageway FP through the pistons 13, $13^1$, the chambers 20, $20^1$ thence exteriorly of the apparatus 10 through the respective lower ends. Accordingly, the fluid within one of the chambers 20, is caused to be introduced into the wellbore WB prior to activation of the other of the chambers $20^1$ and the second, parallel piston $13^1$, as shown in Fig. 6. Such embodiment of the present invention would have application in the event that a polymer composition is desired to be prepared in-situ by means of monomer "A" being placed within fluid chamber 20 and monomer "B" being placed in fluid chamber $20^1$ with requirement that monomer "A" be deposited within wellbore WB for a given time prior to introduction of monomer "B" in chamber $20^1$ into the wellbore WB at a subsequent, or delayed time.

**[0024]** Now, with reference to Fig. 8, there is shown an alternative embodiment of the present invention in which the fluid injection apparatus 10 actually is a part of the conduit CT and is not provided at the lowermost end of the conduit CT by threads 11 engaging the apparatus 10 to the lowermost end of the conduit CT.

OPERATION

**[0025]** When it is desired to treat the wellbore WB and/or the fractures F through the perforations P in the casing C, the apparatus 10 is secured by threads 11 to the lowermost end of the conduit CT. Thereafter, the treatment fluid is introduced into the fluid chamber 20 by means of the port 12C and the floating piston 13 moves to the position as shown in Fig. 1. The port 12C is plugged by introduction of the plug 12D therethrough. Now, the apparatus 10, is run into the wellbore WB on the lowermost end of the conduit CT until such time as the approximate lowermost end of the apparatus 10 is parallel to the perforations P. Now, pressure is applied to the fluid within the conduit CT and the fluid passageway FP to be applied the upper face of the piston 13A and compressing the fluid within the fluid chamber 20. As the pressure within the chamber 20 is increased, the shear value of the pins 13 and 14 will be exceeded, causing the pins 13 and 14 to break and, thus, discharge the blowout plug 15 through the lowermost end of the apparatus 10. The treatment fluid within the fluid chamber 20 is discharged and the discharge is continued through continued application of pressure within the conduit CT such that the floating piston 13 travels downwardly within the fluid chamber 10 until it no-goes by the contact of the lower face 13B with the shoulder 12B of the piston seat sub 12A. Such position is as shown in Fig. 2.

**[0026]** When the embodiment of the invention is utilized as shown in Figs. 3 and 4, the piston 13 is pumped to the position shown in Fig. 4 to positively discharge all of the fluid from within the fluid chamber 20. Thereafter, fluid pressure within the conduit CT and the fluid passageway FP is continued to be increased until such time as the diaphragm 13D is ruptured. Upon rupture of the diaphragm 13D, fluid within the conduit CT may pass through the passageway or opening 13C within the interior of the floating piston 13, thence through the outer open end of the apparatus 10 for introduction into the wellbore WB, for spotting, circulation, and/or recirculation, as the occasion merits.

**[0027]** Now with reference to the embodiment of the invention shown in Figs. 5, 6, and 7, separate treatment fluids are deposited and prepared as above, for each of fluid chambers 20 and $20^1$. Pressure is applied to each of the floating pistons 13, $13^1$, but the shear strength of shear pin $13^1$ being considerably more than that in shear pin 13 for plug 15, the floating piston 13 is permitted to move to compress the fluid within chamber 20 to shearpin 13 and remove plug 15, thereby discharging the first fluid within fluid chamber 20. Pressure is continued to be applied within the conduit CT fluid passageway FP against the uppermost end $13A^1$ of the piston $13^1$ to cause same to move to the position as shown in Fig. 7, resulting in the discharge of the second treatment fluid within fluid chamber $20^1$. Thereafter, the rupture disk elements 13D and $13D^1$ within each of the piston members 13 and $13^1$ may be broken to permit fluid within the fluid passageway FP to pass through both of the fluid chambers 20, $20^1$ and into the wellbore WB.

**[0028]** The embodiment of the apparatus 10 shown in Fig. 8 provides for the interior of the conduit CT to be the fluid chamber 20 which is blocked or isolated by means of one floating piston 13 bridging the fluid chamber 20 and the fluid passageway FP in the conduit CT thereabove. The apparatus is activated and operated as for the embodiment as shown in Figs. 3 and 4.

**[0029]** Although the invention has been described in terms of specified embodiments which are set forth in detail, it should be understood that this is by illustration only and that the invention is not necessarily limited thereto, since alternative embodiments and operating techniques will be come apparent to those skilled in the art in view of the disclosure. Accordingly, modifications are contemplated which can be made without departing from the spirit of the described invention.

**Claims**

1. A fluid injection apparatus with controlled volume displacement for use in a subterranean well and carriable therein on a conduit including a fluid passageway, said apparatus comprising:

   (a) a cylindrical housing having an interior fluid chamber;
   (b) means at one end of said housing for securing said apparatus to said conduit;
   (c) piston means within said chamber for isolating fluid within said chamber from said passageway and movable from a first position whereby said chamber is in expanded condition and retaining fluid therein to a second position whereby said chamber is in a contracted condition and said fluid is ejected from said chamber and into said well.

2. The apparatus of Claim 1 further comprising means activatable in response to movement of said piston means toward said second position for opening said chamber and ejection therefrom of said fluid.

3. The apparatus of Claim 1 wherein said housing includes means for retaining one end of said chamber in closed condition and activatable in response to movement of said piston means toward said second position for opening said chamber and ejection therefrom of said fluid.

4. The apparatus of Claim 1 wherein said piston means includes an opening therethrough extending between said passageway and said fluid chamber, and means for selectively blocking said opening.

5. The apparatus of Claim 4: said selective blocking means being responsive to fluid pressure variance within said chamber to unblock and open said opening.

6. The apparatus of Claim 4: said selective blocking means being responsive to an increase of pressure within said conduit to open said opening.

7. The apparatus of Claim 3 wherein said means for retaining one end of said chamber in closed condition is activatable in response to a first level of fluid pressure.

8. The apparatus of Claim 4: said selective blocking means being responsive to fluid pressure to unblock and open said opening and said means for retaining one end of said chamber in closed condition is activatable in response to a first level of fluid pressure, said selective blocking means being responsive to a second and increased level of fluid pressure to open said opening subsequent to ejection of substantially all fluid within said chamber and into said well.

9. A fluid injection apparatus with controlled volume displacement for use in a subterranean well and carriable therein on a conduit including a fluid passageway, comprising:

(a) a plurality of cylindrical housings, each having an interior fluid chamber;
(b) means at one end of at least one of said housings for securing said apparatus to said conduit; and
(c) piston means within each of said chambers for isolating fluid within each of said chambers from said passageway and moveable from a first position whereby each of said chambers is in an expanded position retaining fluid therein to a second position whereby each of said chambers is in a contracted condition and said fluid is ejected from each of said chambers and into said well.

10. The apparatus of Claim 9 wherein the piston means within one of said chambers is moved to said second position prior to movement of another piston means from said first position.

11. The apparatus of Claim 9 further including a first treatment fluid within one of the plurality of chambers and a second treatment fluid another of the plurality of within chambers.

12. A subterranean well conduit for injection of a treatment fluid for treatment of a zone within said well, comprising:

(a) an interior fluid chamber within said conduit; and
(b) piston means forming one end of said chamber and moveable from a first position whereby said chamber is in an expanded condition retaining the treatment fluid therein to a second position whereby said chamber is in a contracted condition and said treatment fluid is ejected from said chamber and out of said conduit and into said well.

13. A method of ejecting a treatment fluid into a subterranean well through a conduit introduced through and extending into said well, comprising the steps of:

(a) providing a fluid injection apparatus comprising:

(1) a cylindrical housing having an interior fluid chamber;
(2) means at one end of said housing for securing said apparatus to said conduit;
(3) piston means within said chamber for isolating fluid within said chamber from said passageway and movable from a first position whereby said chamber is in expanded condition retaining fluid therein to a second position whereby said chamber is in a contracted condition and said fluid is ejected from said chamber and into said well;
(b) introducing the treatment fluid into said chamber;
(c) running said apparatus into said well on said conduit to a pre-determinable position within said well; and
(d) applying pressure within said conduit to said piston means to move said piston means and eject said treatment fluid from within said chamber and into said well.

14. A method of ejecting a treatment fluid into a subterranean well through a conduit introduced through and extending into said well, comprising the steps of:

(a) providing a fluid injection apparatus comprising:

(1) a cylindrical housing having an interior fluid chamber;
(2) means at one end of said housing for securing said apparatus to said conduit;
(3) piston means within said chamber for isolating fluid within said chamber from said passageway and movable from a first position whereby said chamber is in ex-

panded condition retaining fluid therein to a second position whereby said chamber is in a contracted condition and said fluid is ejected from said chamber and into said well; and

(4) means activatable in response to movement of said piston means toward said second position for opening said chamber and ejection therefrom of said fluid;

(b) introducing the treatment fluid into said chamber;

(c) running said apparatus into said well on said conduit to a predeterminable position within said well; and

(d) applying pressure within said conduit to said piston means to move said piston means and activate said activatable means for opening said chamber to eject said fluid therefrom.

**15.** A method of ejecting a treatment fluid into a subterranean well through a conduit introduced through and extending into said well, comprising the steps of:

(a) providing a fluid injection apparatus comprising:

(1) a cylindrical housing having an interior fluid chamber;

(2) means at one end of said housing for securing said apparatus to said conduit;

(3) piston means within said chamber for isolating fluid within said chamber from said passageway and movable from a first position whereby said chamber is in expanded condition retaining fluid therein to a second position whereby said chamber is in a contracted condition and said fluid is ejected from said chamber and into said well; and

(4) means for retaining one end of said chamber in closed condition and activatable in response to movement of said piston means toward said second position for opening said chamber and ejection therefrom of said fluid.

(b) introducing the treatment fluid into said chambers;

(c) running said apparatus into said well on said conduit to a pre-determinable position within said well; and

(d) applying pressure within said conduit to set piston means to move said piston means and eject said treatment fluid from within said chamber and into said well.

**16.** A method of ejecting a treatment fluid into a subterranean well through a conduit introduced through and extending into said well, comprising the steps of:

(a) providing a fluid injection apparatus comprising:

(1) a cylindrical housing having an interior fluid chamber;

(2) means at one end of said housing for securing said apparatus to said conduit;

(3) piston means within said chamber for isolating fluid within said chamber from said passageway and movable from a first position whereby said chamber is in expanded condition retaining fluid therein to a second position whereby said chamber is in a contracted condition and said fluid is ejected from said chamber and into said well, said pisron means including an opening therethrough extending between said passageway and said fluid chamber; and

(4) means for selectively blocking said opening in said piston means.

(b) introducing the treatment fluid into said chamber;

(c) running said apparatus into said well on said conduit to a pre-determinable position within said well;

(d) applying pressure within said conduit through said piston means to move said piston means and eject said treatment fluid from within said chamber and into said well; and

(e) varying the pressure within the conduit to unblock said opening and pumping through said conduit, said opening and said chamber a second fluid for introduction into said well.

**17.** A method of ejecting a treatment fluid into a subterranean well through a conduit introduced through and extending into said well, comprising the steps of:

(a) providing a fluid injection apparatus comprising:

(1) a plurality of cylindrical housings, each having an interior fluid chamber;

(2) means at one end of at least one of said housings for securing said apparatus to said conduit; and

(3) piston means within each of said chambers for isolating fluid within each of said chambers from said passageway and moveable from a first position whereby each of said chambers is in an expanded

position retaining fluid therein to a second position whereby each of said chambers is in a contracted condition and said fluid is ejected from each of said chambers and into said well;

(b) introducing a treatment fluid into each of said chambers;
(c) running said apparatus into said well on said conduit to a pre-determinable position within said well;
(d) applying pressure within said conduit to one of said piston means to move one of said piston means and eject treatment fluid within one of said chambers and into said well; and
(e) varying the pressure within said conduit and applying said varied pressure to another of said piston means to move said other of said piston means and eject treatment fluid from within another of said chambers and into said well.

Fig. 1

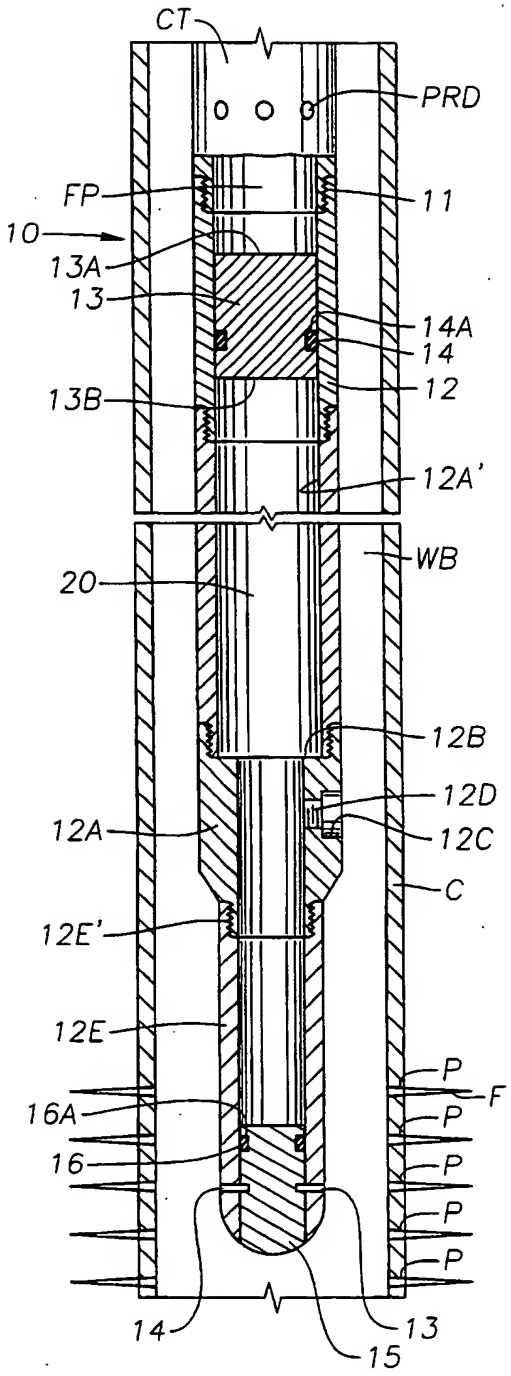

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Fig. 2

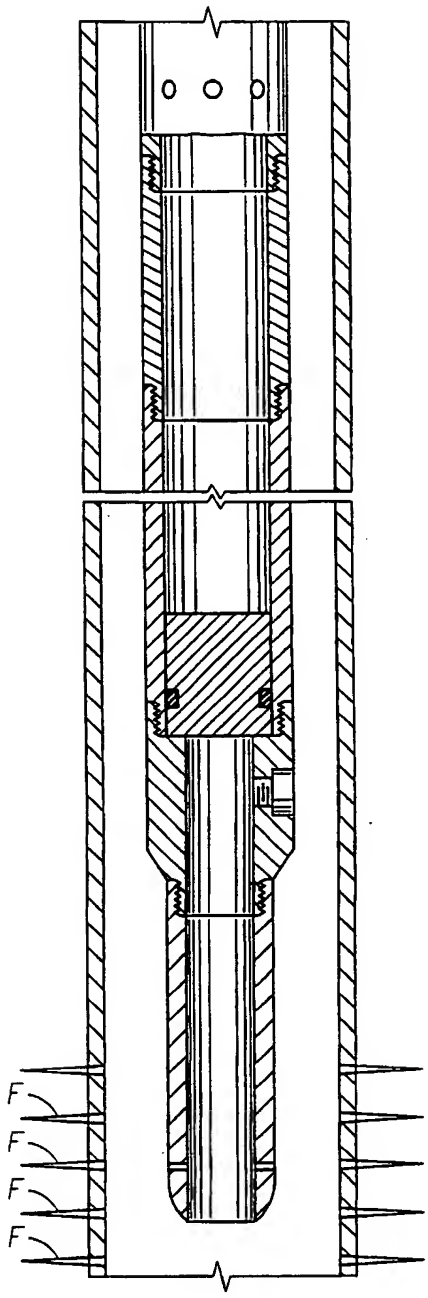
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Fig. 3

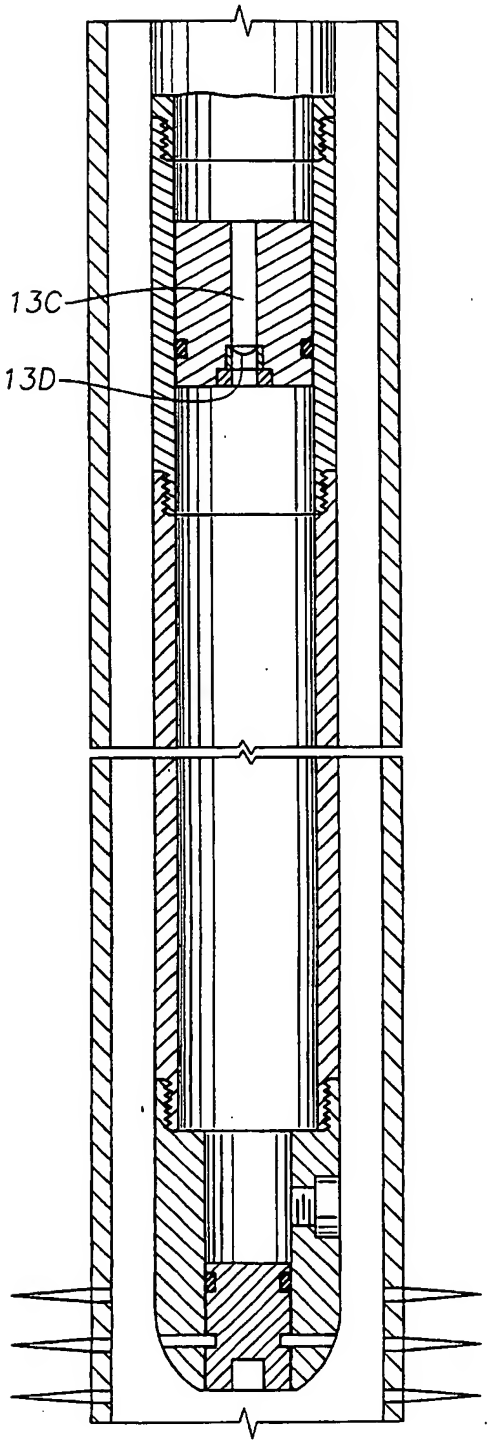



Fig. 4

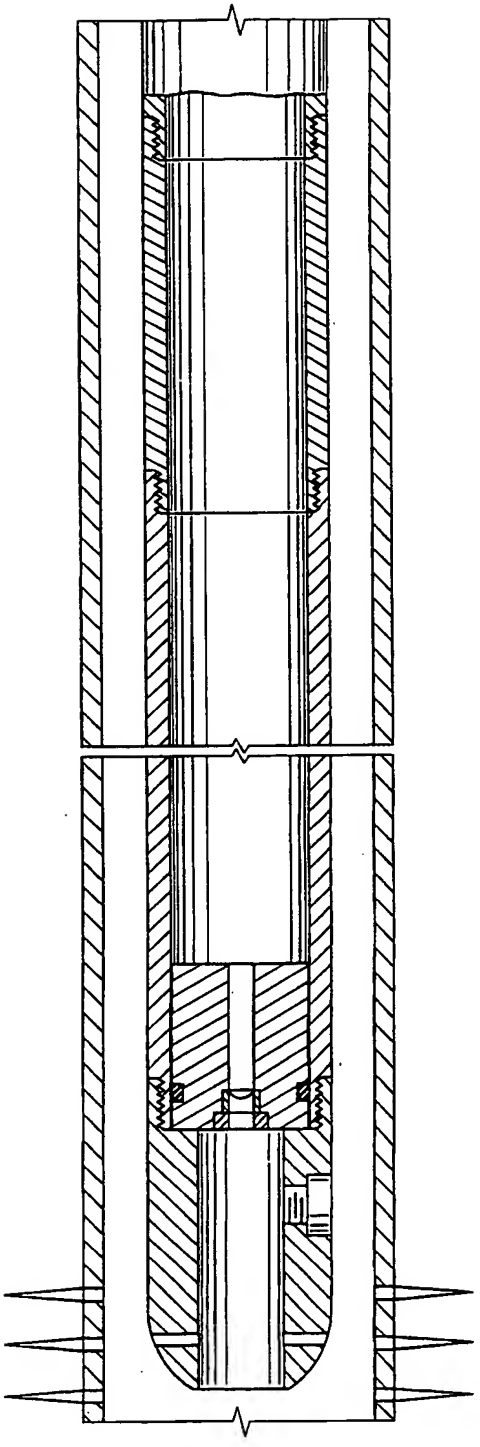


Fig. 5

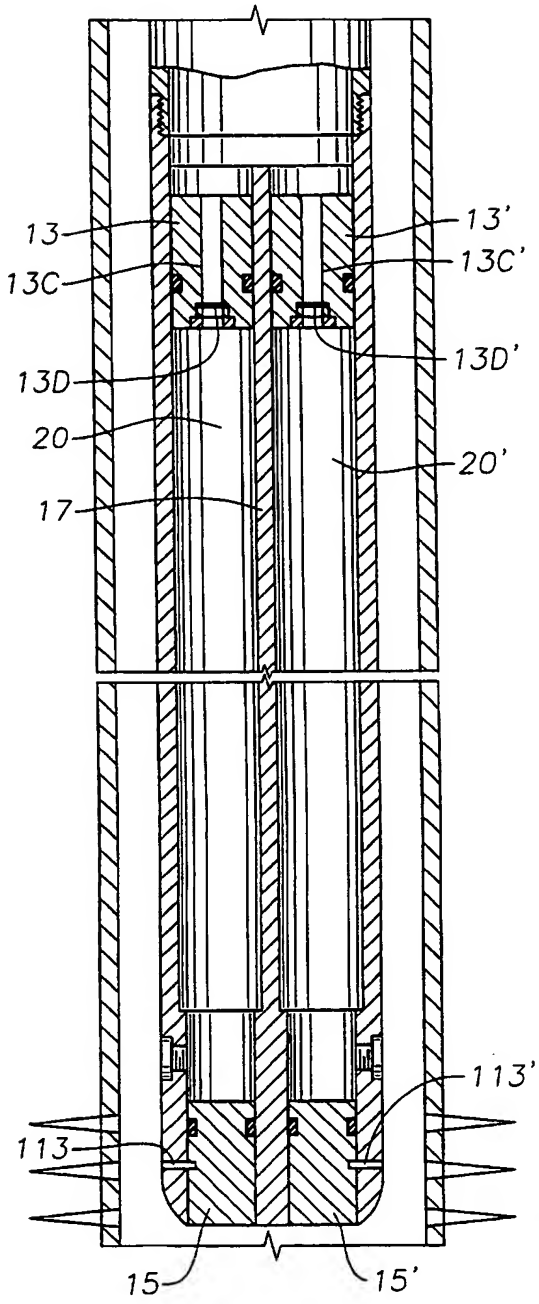



Fig. 6

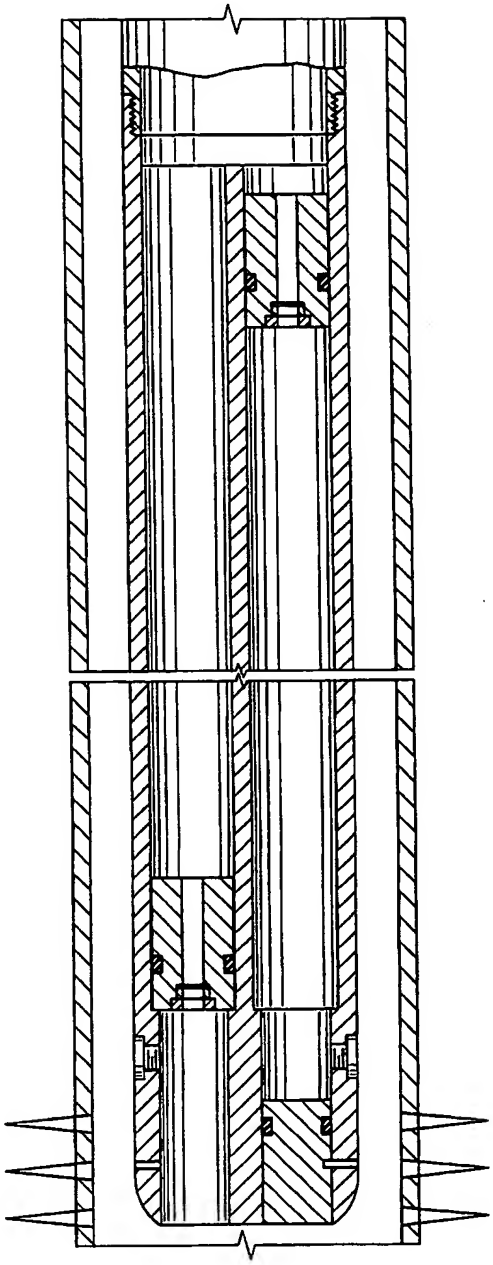


Fig. 7

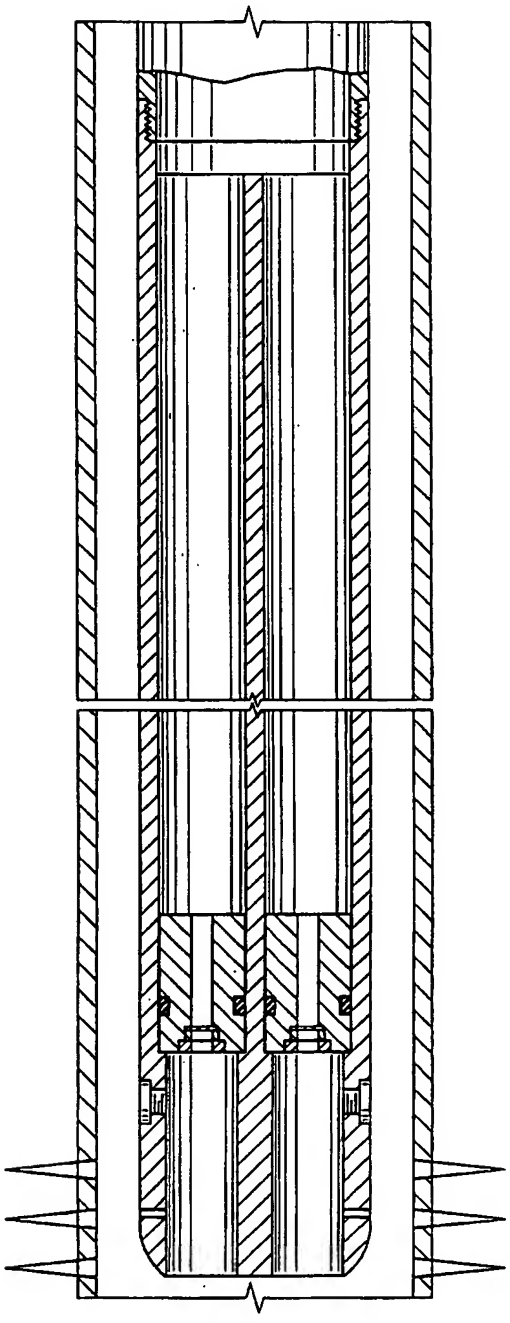
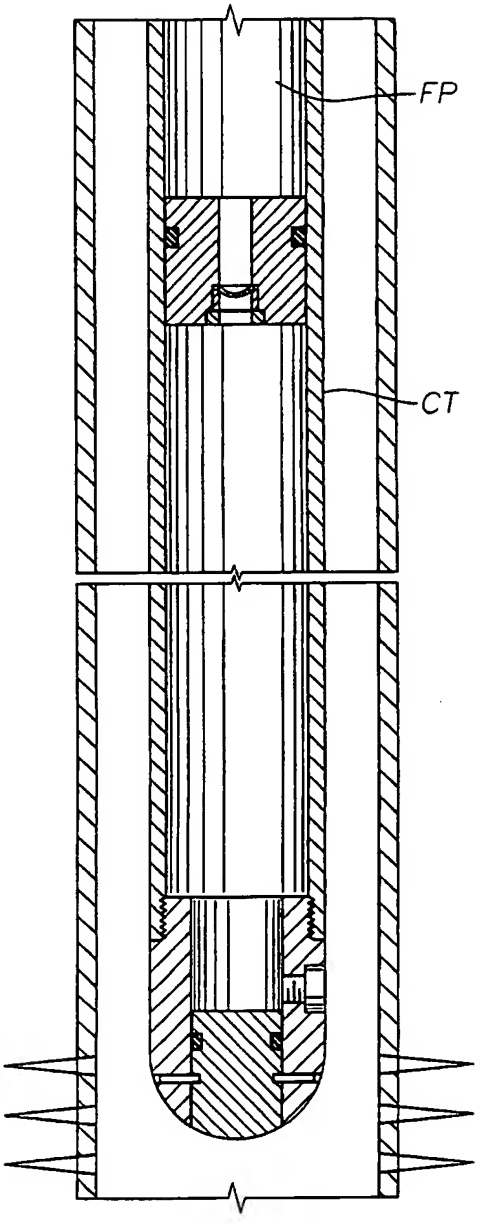


Fig. 8



European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 01 30 0538

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
|---|---|---|---|
| X | US 3 273 647 A (BROWN TIMOTHY D ET AL) 20 September 1966 (1966-09-20) * column 3, line 64 - line 75 * * column 4, line 36 - line 39; figures 2,4 * * column 6, line 18 - line 39 * --- | 1,9-13, 17 | E21B27/02 E21B43/25 E21B21/12 |
| X | US 5 582 251 A (BAILEY J ROBERT ET AL) 10 December 1996 (1996-12-10) * column 3, line 53 - column 4, line 13; figure 1 * * column 2, line 48 - line 52 * --- | 1-3,7,9, 11-15 | |
| X | US 2 986 212 A (SCHULTZ WILBURN E) 30 May 1961 (1961-05-30) * claim 1; figures 1,2 * --- | 1-3, 12-15 | |
| P,X | WO 00 66878 A (UNIV CALIFORNIA) 9 November 2000 (2000-11-09) * page 20, line 18 - page 21, line 6; figure 1 * * page 21, line 15 - page 22, line 8 * --- | 1-3,7, 12-15 | |
| E | WO 01 38691 A (HEIJNEN WILHELMUS HUBERTUS PAU ;MORATO PENA MARIA JOAO RAMOS C (NL)) 31 May 2001 (2001-05-31) * claims 1,3-5; figure 1 * --- | 1-3,7, 12-15 | |
| A | US 5 425 424 A (REINHARDT PAUL A ET AL) 20 June 1995 (1995-06-20) * column 4, line 56 - column 5, line 61; figures 8-11 * --- | 1,9, 12-17 | |
| A | US 4 279 304 A (HARPER JAMES C) 21 July 1981 (1981-07-21) * column 4, line 30 - line 43; figure 1 * * column 4, line 57 - line 62 * ----- | 1,9, 12-17 | |

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

E21B

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 23 May 2002 | Dantinne, P |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

Application Number
EP 01 30 0538

## CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

## LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☒ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

European Patent Office

## LACK OF UNITY OF INVENTION
## SHEET B

Application Number
EP 01 30 0538

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-8,12-16

   Fluid injection apparatus with a cylindrical housing and an interior fluid chamber.

2. Claims: 9-11,17

   Fluid injection apparatus with a plurality of cylindrical housings, each having an interior fluid chamber.

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 30 0538

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

23-05-2002

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82